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ABSTRACT

This essay is divided into three sections that explain the history of mathematics reform and its conflicts focusing on the controversial California mathematics standards, discussing assumptions about ethnicity and gender in the mathematics reform movement, and describing the incorporation of technology into the mathematics curriculum. (Contains 22 references.) (YDS)

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From: the book, "How To Teach Mathematics," by Steven Krantz, published by the American Mathematical Society, January 1999.

Big Business, Race, and Gender in Mathematics Reform

David Klein

The mathematics reform movement may have positive attributes, but that is not what this appendix is about. This essay is divided into three sections, each taking a critical view of what has come to be called ``mathematics reform." Rather than attempting an abstract definition of this term, I cite the principal documents and leaders of the reform movement on particular issues. The fault line separating the mathematics reform movement from its critics is nowhere more volatile and portentous than in California. The third and final section of this appendix is devoted to a short history of the conflict over mathematics reform in that state, with a focus on the controversial California mathematics standards. This set of standards has received widespread praise from prominent mathematicians and strong opposition from the mathematics reform community. As explained in the last section, this conflict helps to define, in *practical* terms, the mathematics reform movement.

The second section challenges assumptions about ethnicity and gender in the reform movement. Multiculturalism and mathematics for ``all students" are recurring themes among reformers. Prominent reformers claim that learning styles are correlated with ethnicity and gender. But reform curricula, while purporting to reach out to students with different ``learning styles," actually limit opportunities. Fundamental topics, including algebra and arithmetic are abridged or missing in reform curricula without apology.

Big Business and the mathematics reform movement have at least one thing in common. They both militate for more technology in the classroom. Calculators and computers are regular features in reform math curricula, and technology corporations routinely sponsor conferences for mathematics educators. The confluence of interests and the resulting momentum in favor of more technology is the subject of the first section.

Technology, Reform, and the Corporate Influence

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> *In spite of the intimate intellectual link between mathematics and computing, school mathematics has responded hardly at all to curricular changes implied by the computer revolution. Curricula, texts, tests, and teaching habits--but not the students--are all products of the pre-computer age. Little could be worse for mathematics education than an environment in which schools hold students back from learning what they find natural.* [NRC]

The imperative to integrate technology into the classroom goes far beyond mathematics courses. President Clinton calls for ``a bridge to the twenty first century...where computers are as much a part of the classroom as blackboards." [O] Presently, four-fifths of U.S. schools are wired to the Internet and the rest are not far behind. Remonstrations by well-placed technology experts and educators, based on educational considerations, seem to warrant no delays [G], [O]. A 1996 report by the California Education Technology Task Force, a group dominated by executives in high-tech industries, called on California to spend $10.9 billion on technology for schools before the end of the century. The task force claimed that ``more than any other single measure, computers and network technologies, properly implemented, will bolster California's continuing efforts to right what's wrong with our public schools." [LAT1]

A corporate perspective is also sweeping American universities with computer technology paving the way. The number of virtual universities and virtual courses is increasing exponentially. In 1997 there were 762 ``cyberschools," up from 93 in 1993 and more than half of the nation's four year colleges and universities have courses available ``off site" [F]. The second largest private university in the U.S., the University of Phoenix, offers on-line courses to 40,000 students from a faculty with no tenure. Other examples* and a recent history of technology and the corporatization of universities may be found in David Noble's interesting essays [N].

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* During the mid-1990's the California State University administration initiated an unprecedented partnership with technology giants Microsoft, GTE, Fujitsu and Hughes Electronics. The joint venture, called the California Educational Technology Initiative, or CETI, will, if implemented, wire up the 23 campuses of the CSU with state-of-the-art telephone and computer networks, as well as invest billions of dollars in education related electronics. By the Spring of 1998, a dozen CSU campus faculty senates passed resolutions asking for delays and criticizing the merger. The California State Student Association passed its own resolution denouncing CETI and opposing any "privatization of the California State University as a whole." Microsoft and Hughes subsequently pulled out, but CSU Chancellor Reed continues to seek new corporate partners. The implications of such a partnership are not fully worked out, but incentives for the faculty to market computer products to students, and the creation and marketing of courseware have been seriously considered.

Will the computerization of schools improve education? The Los Angeles Times reports that ``many critics worry that education policy is increasingly being driven by what companies have to sell rather than what schools need...Computer companies want more technologically savvy consumers, for example, to increase the penetration of computers beyond the 40% of homes in which they are now found. And they argue that increased use of technology in schools will help fill a growing shortage of computer literate workers." [LAT1]

Corporate foundations regularly fund mathematics reform projects, as for example, the ``Exxon Symposium on Algebraic Thinking" for the Association of Mathematics Teacher Educators Conference, held in January 1998, with Texas Instruments hosting one of the dinners. Conversely mathematics reformers embrace a corporate vision of education, which includes the de-emphasis of basic skills and a greater reliance on technology. Consider, for example, the following promotional material for the K-6 curriculum MathLand from Creative Publications:

> *Business leaders have expressed interest in changes in education as well--changes that go beyond what a traditional standardized test can measure. Recently, the US Departments of Labor and Education formed the Secretary's Commission on Achieving Necessary Skills (SCANS) to study the kinds of competencies and skills that workers must have to succeed in today's workplace. According to the SCANS report What Work Requires of Schools: A SCANS Report for America 2000, business leaders see computation as an important skill, but it is only one of 13 skills desired by Fortune 500 companies. These skills are (in order of importance): teamwork, problem solving, interpersonal skills, oral communication, listening, personal development, creative thinking, leadership, motivation, writing, organization skills, computation, and reading.* [ML]

The California Mathematics Council (CMC), an affiliate of the National Council of Teachers of Mathematics, boasts 12,000 members. In an open letter to the California Board of Education dated April 17, 1996, the CMC included the same ordered list of basic skills with reading and computation given last. Citing unspecified ``educational research" and ``neuro-biological brain research," the CMC letter endorsed the direction of the 1992 reform oriented California Mathematics Framework and added:

Equally impressive is that these changes in the way we teach mathematics are supported by the business community. What Work Requires of Schools: A SCANS Report for America 2000 concludes that students must develop a new set of competencies and new foundation skills. It stresses that skills must be learned in context, that there is no need to learn basic skills before problem solving, and that we must reorient learning away from mere mastery of information toward encouraging students to solve problems.

Learning in order to know must never be separated from learning to do. Knowledge and its uses belong together (A SCANS Report) [CMC]

The NCTM Curriculum and Evaluation Standards also recommends that ``appropriate calculators should be available to all students at all times" and ``every student should have access to a computer for individual and group work." Reform texts place little restriction on technology. The second edition of the Harvard Calculus text instructs that students ``are expected to use their own judgment to determine where technology is useful." [HAL] The 1992 California Mathematics Framework recommends that calculators be available at all times to all students, including Kindergarten students, and asks, ``How many adults, whether store clerks or bookkeepers, still do long division (or even long multiplication) with paper and pencil?"

None of the above is intended to suggest that technology should not be used in mathematics classes. Nor do I suggest any kind of conspiracy theory. I have incorporated the (limited) use of computers in some of my own classes at California State University, Northridge, and I agree with almost all of Professor Krantz' balanced discussion in Section 1.10. My only reservation is Professor Krantz' suggestion that an entire ``lower division mathematics curriculum [should] depend on Maple (or Mathematica, or another substitute) and that [students] need to master it right away." This seems to me to be premature. It might be appropriate at some point, but a compelling curriculum with this feature should be presented, vigorously reviewed, and thoroughly tested on real students first.

The use of technology in mathematics education should be considered against the backdrop of extremely powerful business interests which seek to create new consumers of technology. Incorporating ever more technology into the classroom may or may not be consistent with good educational practices. Large-scale implementations of technology in the classroom receive

tremendous momentum from funding agencies--at times, far beyond what the results merit. With the huge sums of money involved in computerizing education, the educational merits of technology are rarely discussed. For politicians and entrepreneurs, no justification is necessary, but educators should demand clear evidence of the beneficial effects of technology before it is incorporated in classrooms.

The calculator is one of the staples of the reform mathematics movement from Kindergarten through calculus and beyond. Mathematics instructors, including calculus teachers, regularly allow students to use calculators on examinations and contort their tests to avoid giving points for mere button pressing skills. I agree with Professor Krantz' assertion in Section 1.10 that ``if a student spends an hour with a pencil--graphing functions just as you and I learned--then there are certain tangible and verifiable skills that will be gained in the process." I don't think it is unreasonable to require students to demonstrate these and other skills on examinations without calculator assistance.

At the elementary school level, arithmetic is a victim of technology in the reform curricula. Long division in particular is frequently a target for elimination. For example, long division with more than single digit divisors was consciously eliminated from the proposed California math standards by the Academic Standards Commission, and the California Mathematics Framework makes it clear that ``clerks or bookkeepers ... do [not do] long division ...with paper and pencil." In addition to sharpening estimation skills, mastery of the division algorithm is important for understanding the decimal characterization of rational numbers, a middle school topic, as well as quotients of polynomials and power series in later courses.

In a society that worships technology, it is all too easy to surrender the integrity of sound traditional curricula to machines, their corporate venders, and reform-evangelists.

Gender, Race, and Ethnicity in the Reform Movement

One of the themes of the mathematics reform movement is that women and members of ethnic minority groups learn mathematics differently than white males. The thesis that learning styles are correlated with ethnicity and gender is widely accepted in education circles and its validity is not assumed to be restricted to mathematics. One example of this ideology occurred when the Oakland School Board resolved that Ebonics is genetically based [SFC]. Main-stream views from the academy are similar. In a well-referenced study

on how African Americans learn mathematics, published in the Journal for Research in Mathematics Education, one finds [MJ]:

> *Studies of learning preferences suggest that the African American students' approaches to learning may be characterized by factors of social and affective emphasis, harmony with their communities, holistic perspectives, field dependence, expressive creativity, and nonverbal communication...Research indicates that African American students are flexible and open-minded rather than structured in their perceptions of ideas...The underlying assumption is that the influence of African heritage and culture results in preferences for student interaction with the environment and that this influence affects cognition and attitude...*

The Journal of American Indian Education devoted an entire special issue to the subject of brain hemispheric dominance and other topics involving Native American learning styles. Included is a reprint of Dr. A. C. Ross' paper, ``Brain hemispheric functions and the Native American," that asserts Native Americans are ``right brained." Ross explains that the ``functions of the left brain are characterized by sequence and order while the functions of the right brain are holistic and diffused." Elaborating, he maintains that ``left brain thinking is the essence of academic success as it is presently measured. Right brain thinking is the essence of creativity." Citing earlier research, Ross concludes that ``traditional Indian education was done by precept and example (learning by discovery)...creativity occurs in the learning process when a person is allowed to learn by discovery. Evidently, traditional Indian education is a right hemispheric process." [JAIE] The final article in the same journal takes issue with this point of view and laments that ``a veritable right-brain industry has developed" and warns of the dangers to Indian education by characterizing this entire ethnic group as right brained.

The view that women and minority group members learn differently from white males is far from marginal within the mathematics reform movement. A radio interview of NCTM President Jack Price, independent textbook publisher John Saxon, and Co-Founder of Mathematically Correct, Mike McKeown, occurred on April 24, 1996. The KSDO radio show on Mathematics Education, hosted by Roger Hedgecock, was held in conjunction with the annual meeting of the National Council of Teachers of Mathematics, in San Diego that year. During the interview, President Price asserted:

> *What we have now is nostalgia math. It is the mathematics that we have always had, that is good for the most part for*

> *the relatively high socio-economic anglo male, and that we have a great deal of research that has been done showing that women, for example, and minority groups do not learn the same way. They have the capability, certainly, of learning, but they don't, the teaching strategies that you use with them are different from those that we have been able to use in the past when young people, we weren't expected to graduate a lot of people, and most of those who did graduate and go on to college were the anglo males.* [MC]

The reform movement presupposes that broad classes of non-white males learn ``holistically," that mathematics should be integrated with examples and connected as widely as possible to other human endeavors. Algebra and arithmetic are particularly short changed as ``mindless symbol manipulation" and ``drill and kill." To cite one typical example of this, a mathematics educator wrote on the Association of Mathematics Teacher Educators listserve, ``I know this may come as a shock to some mathematics professors out there, but few students find manipulating 'x' and 'y' engaging."

It is clear that proponents of reform are acting out of a sincere desire to improve mathematics education for all students. But the mathematics community should be suspicious of trends which draw legitimacy from racial or gender theories of learning.

No one disputes that culture plays a role in academic achievement. The Los Angeles Times published a special report entitled, ``Language, Culture: How Students Cope" as part of a three day series of special reports on education [LAT2]. The Times report explicitly discounts any link between race and ability, but acknowledges that ``ethnic differences [in academic accomplishments] remain, even after accounting for income, parent education or language a student speaks at home." High achievement by Asian American students is a result of hard-work and a strong emphasis on the importance of education, and this contrasts sharply with the ``complacency that hampers so many of California's white students, who have shown a sharper drop on reading scores this decade than either blacks or Latinos." ``The burden of acting white" is a theory that African American students ``resist schooling to protect their self-image and distinguish themselves from a majority culture that too often devalues their abilities." Many Latinos, for cultural and economic reasons may see pursuing an education as selfish, since getting a job instead would contribute directly and immediately to family members [LAT2].

Investigating cultural reasons for differences in academic achievement is quite different from proposing that members of different ethnicities and genders actually learn mathematics in different ways. The latter point of view is especially serious when it leads to new, watered-down mathematics curricula.

There should be no doubt that minority students can thrive in traditional programs. Take the case of Bennett-Kew Elementary School in Inglewood, California. According to Principal Nancy Ichinaga, 51% of the students are African-American and 48% are Hispanic (mostly immigrant with Limited English Proficiency). Approximately 70% qualify for subsidized lunches. Below are its 1997 California Achievement Test results, with Normal Curve Equivalent scores (similar to percentiles):

Grade	1	2	3	4	5
Math	62	79	81	75	68

Bennett-Kew believes in high, explicit standards for all students. The mathematics standards are not just year-by-year, but month-by-month. There is regular diagnostic testing of student progress and immediate remediation. The school is committed to direct instruction and does not use newer books. While discussing the mathematics reform movement with me, Principal Ichinaga remarked, "Reform is for the birds."

The traditional approach to teaching calculus used by the legendary teacher Jaime Escalante is another example of minority students thriving in a traditional mathematics program. In 1974, Escalante took a job teaching basic mathematics at Garfield High School which was in danger of losing its accreditation because discipline and test scores were so bad. Five years later, insisting that disadvantaged and minority students could tackle the most difficult subjects, he started a small calculus class. The effect was to raise the curriculum for the entire school. In 1982, 18 of his students passed the Advanced Placement calculus exam. This was the subject of the movie, "Stand and Deliver." Working with his fellow calculus teacher Ben Jimenez, and Garfield Principal Henry Gradillas, Escalante sent ever increasing numbers of students to leading universities with AP calculus credit.

By 1987, Garfield High School had more test takers than all but four high schools in the United States. The number of test takers reached its peak of 143 students in 1991, the year Escalante left Garfield. The passage rate was 61%. The numbers have declined ever since. By 1996 there were only 37 test takers with a passage rate of 19%. It is interesting that former Principal Gradillas' career declined after the spectacular successes of his high school.

After finishing his doctorate in 1987, he ``expected to be given an important administrative job that would help spread the school's philosophy to other parts of Los Angeles. Instead he was told to supervise asbestos inspections of school buildings. District officials denied they were punishing him, but one said privately that Gradillas was refused better assignments because he was considered 'too confrontational.'" [WP]. Rather than studying his effective methods, Escalante is shunned by the mathematics reform community. The disapproval is mutual. According to Escalante, ``whoever wrote [the NCTM math standards] must be a physical education teacher." [CS]

The calculus reform movement is inextricably linked to the K-12 mathematics reform movement. Consider, for example, the following statement from the preface of the first edition to the Harvard Calculus text [HAL]:

> *We have found this curriculum to be thought-provoking for well-prepared students while still accessible to students with weak algebra backgrounds. Providing numerical and graphical approaches as well as the algebraic gives the students several ways of mastering the material. This approach encourages students to persist, thereby lowering failure rates.*

Lower failure rates at the cost of eviscerating the algebra component of calculus is harmful to students of all ethnicities and both genders. Algebra and arithmetic are consistently de-emphasized in reform curricula in exchange for the more ``holistic" calculator assisted ``guess and check" routine. The entire reform program mortgages future opportunities to attend to the immediacy of high failure rates. The de-emphasis of algebra in reform calculus justifies and caters to the K-12 reform mathematics program.

Calculus proofs and even definitions require students to be competent in algebra. Calculus reform texts tend to relegate both of these to appendices, sparing students the necessity even to turn a few pages in order to avoid them. Instructors who wish to include definitions, such as the definition of a limit and/or a few proofs, must overcome additional psychological resistance because of the location of these topics in the textbooks. When a proof or definition is placed in an appendix, it sends the message to the student that the topic is not important and may be safely skipped.

The emergence of these trends at a time when greater numbers of previously under-represented students are attending universities should cause some reflection within the mathematics community. Are we expecting less of these students? If so, is it because they learn mathematics differently from

students of an earlier era, or is it because their mathematical preparations are deficient? I think it is the latter, and I believe that the mathematics community would do well to purge itself of any hidden assumptions that non-Asian minority students learn mathematics differently from anybody else. The focus should be on raising the level of mathematics education in K-12, not on how best to lower it in the universities.

The Politics of Mathematics Reform in California

Nowhere has the conflict over mathematics education reform been more contentious than in California. California led the United States in institutionalizing K-12 mathematics reform. The 1992 California Mathematics Framework is based on the 1989 NCTM Standards and has served as a guide for politically powerful reformers, like the California Superintendent of Instruction, Delaine Eastin (elected in 1994), as well as countless specialists in the state's Colleges of Education who have used it as course material for K-12 student teachers. But California's commitment to the principles of mathematics reform predates the NCTM Standards. For example, one finds in the 1985 ``California Model Curriculum Standards, Grades Nine Through Twelve'':

> *The mathematics program must present to students problems that utilize acquired skills and require the use of problem-solving strategies. Examples of strategies that students should employ are: estimate, look for a pattern, write an equation, guess and test, work backward, draw a picture or diagram, make a list or table, use models, act out the problem, and solve a related but simpler problem. The use of calculators and computers should also be encouraged as an essential part of the problem-solving process. Students should be encouraged to devise their own plans and explore alternate approaches to problems.*

The educational philosophies behind the mathematics reform movement are canonical in America's colleges of education and have been for most of this century [H]. The broad principles of reform have been institutionalized in California state documents for well over a decade and have taken root in the schools. Reform curricula based on these principles are ubiquitous in California's elementary schools. The controversial curriculum, ``MathLand,'' for example, has been adopted by 60% of the state's public elementary schools, according to its publishers [T], and there are many other similar curricula widely in use. Secondary mathematics curricula such as Interactive Mathematics Program and College Preparatory Mathematics originated in

California and are widely used throughout the state at the time of this writing. The alignment of these and other self-described reform curricula with the NCTM Standards seems to be uncontested. Indeed, much of the development and implementation of these curricula has been funded by the National Science Foundation and other powerful, reform dominated institutions. In particular, MathLand, perhaps the worst of all reform curricula, has been promoted through the NSF funding.

California is experiencing a backlash at the grass-roots level against the general education reform movement (including Whole Language Learning and ``Integrated Science''), and mathematics reform in particular. Reacting to the de-emphasis of arithmetic and algebra in the reform curricula, and the over-reliance on calculators, parents' education organizations have emerged all over the state, several with their own web sites containing material starkly critical of ``reform math'' or ``fuzzy math.'' I am associated with the largest and best known of these groups, ``Mathematically Correct.''

Of particular concern to parents and teachers critical of the reform movement is the lack of accountability and measurable standards of achievement in the schools. ``Authentic assessment'' in place of examinations with consequences, and little if any importance placed on student discipline and responsibility in the reform literature, help to make reform math an object of ridicule among vocal parents' groups. It is noteworthy that all parties acknowledge the importance of better teacher training.

The conflict between the mathematics reform movement, on the one hand, and parents' organizations combined with a significant portion of the mathematics community, on the other hand, reached a turning point in December 1997. At that time the California Board of Education rejected the reform-oriented draft standards from one of its advisory committees-- the Academic Standards Commission--and, with the help of Stanford mathematics professors Gunnar Carlsson, Ralph Cohen, Steve Kerckhoff, and Jim Milgram, developed and adopted the California Mathematics Academic Content Standards [CA].

Unlike the Academic Standards Commission proposal, these new standards made no pronouncements about teaching methods, only grade-level benchmarks. The reaction from the California mathematics reform community against this lack of coercion was swift and harsh. Their response was to claim that the official math standards, written by the Stanford mathematicians, lowered the bar. Turning reality on its head, State Superintendent Delaine Eastin charged, ``[The State Board of Education Standards] is 'dumbed-down' and is unlikely to elicit higher order thinking...''

Judy Codding, a member of the Academic Standards Commission and the powerful National Center on Education and the Economy put it bluntly when she said, "I will fight to see that [the] California Math Standards are not implemented in the classrooms" [Wu].

Other Reformers with national stature echoed the outrage. Luther Williams, the National Science Foundation's Assistant Director for Education and Human Resources, wrote a retaliatory letter to the California Board of Education widely interpreted as threatening to cut off funding of NSF projects in California. The lead story in the February 1998 News Bulletin of the NCTM, "New California Standards Disappoint Many," began with the sentence, "Mathematics education in California suffered a serious blow in December." The article quotes a letter from NCTM President Gail Burrill to the president of the California Board of Education that included the statements: "Today's children cannot be prepared for tomorrow's increasingly technological world with yesterday's content...The vision of important school mathematics should not be one that bears no relation to reality, ignores technology, focuses on a limited set of procedures, ...California's children deserve more." Presumably the accusation that technology is ignored refers in part to a policy decision of the California Board of Education that statewide exams based on the new math standards will not include the use of calculators--a serious blow to the corporate/reform ideology.

Joining the reform math community, the statewide chairs of the Academic Senates of the UC, CSU, and California Community College systems, none of whom were mathematicians, issued a joint statement condemning the adoption of California's math standards and even suggested that "the consensus position of the mathematical community" was in opposition to the new standards, and generally in support of the rejected, reform-inspired draft standards written by the Academic Standards Commission.

In opposition to the reform community and in support of California's new math standards, more than 100 California college and university mathematicians endorsed an open letter addressed to the Chancellor of the 23-campus California State University system. The open letter disputed the existence of such a consensus and urged the Chancellor to "recognize the important and positive role California's recently adopted mathematics standards can play in the education of future teachers of mathematics in the state of California." Among the endorsing mathematicians were several department chairs and many leading mathematicians [L].

Further contradicting the reformers' claims against California's math standards, Ralph Raimi and Lawrence Braden, on behalf of the Fordham

Foundation, conducted an independent review of the mathematics standards from 46 states and the District of Columbia, as well as Japan. California's new board-approved mathematics standards received the highest score, outranking even those of Japan [FR].

The sharp conflict over the California math standards defined, in practical terms, the mathematics reform movement. Reformers denounced the state's standards in public forums and the press, while traditionalists and critics of reform defended the standards. Based on purely mathematical considerations, the board-approved California standards are easily seen to be superior to the rejected, reform-oriented version offered by the Academic Standards Commission. A careful and well-written comparison these two sets of standards by Hung-Hsi Wu is available on the Mathematically Correct web site [Wu].

The extent to which the California math standards will be taken seriously by school districts is difficult to predict. The superintendent of the Los Angeles Unified School District, the second largest school district in the U.S., admonished LAUSD personnel to take no action to implement the new standards, arguing instead that the already existing LAUSD standards were superior. A refutation and insightful comparison of the LAUSD math standards with the California standards was developed by Jim Milgram, Mathematically Correct Co-Founder Paul Clopton, and others. It is also available on the ``Mathematically Correct" web site [MC]. The LAUSD K-12 math standards are vague and repetitive, trigonometry is completely missing, and third graders are encouraged to use calculators.

Opposition to California's mathematics standards from reform leaders continues as of this writing. Former NCTM president Jack Price wrote in a letter published by the Los Angeles Times on May 10, 1998:

> *...if the state board had adopted world-class mathematics standards for the 21st century instead of the 19th century, there would have been a great deal of support from the 'education' community.*

This sententious observation encapsulates the topics discussed in this essay. For the reformers, ``world-class mathematics standards for the 21st century" eluded the Stanford mathematicians who wrote California's 1998 math standards. Missing are the greater emphasis on technology--an end in itself--and pedagogical directives harmonious with the reified ``cognitive styles" of the racially diverse populations of the 21st century. The ``19th century" arithmetic, algebra, geometry, and trigonometry highlighted in California's

1998 standards will have diminished value in the postmodern epoch of technological wonderments envisioned by math reformers.

Perhaps the academic community should consider whether the discipline of mathematics education--much more so than mathematics--needs fundamental alterations for the 21st century.

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